Bemidji Area Schools

Grades 11-12 General Physics Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.	9.1.1.1.1 Explain the implications of the assumption that the rules of the universe are the same everywhere and these rules can be discovered by careful and systematic investigation.	General discussion of hypothesis. Theory and law and how they do not lie on a continuum. Density Lab.
			9.1.1.1.2 Understand that scientists conduct investigations for a variety of reasons, including: to discover new aspects of the natural world, to explain observed phenomena, to test the conclusions of prior investigations, or to test the predictions of current theories.	General discussion on the history of science. Density lab.
			9.1.1.1.3 Explain how the traditions and norms of science define the bounds of professional scientific practice and reveal instances of scientific error or misconduct. *For example:* The use of peer review, publications and presentations.	Discussion on Newton's Laws.
			9.1.1.1.5 Identify sources of bias and explain how bias might influence the direction of research and the interpretation of data. *For example:* How funding of research can influence questions studied, procedures used, analysis of data, and communication of results.	Discussion on most labs. How their findings may be what they thought they should get instead of what it was actually.
			9.1.1.1.6 Describe how changes in scientific knowledge generally occur in incremental steps that include and build on earlier knowledge.	General discussion on the history of science and how new ideas and technology change the way we practice science. Density Lab.
			9.1.1.1.7 Explain how scientific and technological innovations-as well as new evidence-can challenge portions of, or entire accepted theories and models including, but not limited to: cell theory, atomic theory, theory of evolution, plate tectonic theory, germ theory of disease, and the big bang theory.	Discussion on cell phone, computers advancement, atomic models.

Bemidji Area Schools

Grades 11-12 General Physics Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.	9.1.1.2.1 Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations, and draw conclusions supported by evidence from the investigation.	General discussion on data analysis and uncertainty examined on every lab.
			9.1.1.2.2 Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the scientifically acceptable evidence, and suggesting alternative scientific explanations.	Discussion on every lab checking student work compared to knowns.
		1. Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.	9.1.2.1.3 Explain and give examples of how, in the design of a device, engineers consider how it is to be manufactured, operated, maintained, replaced and disposed of.	Class discussion on engineering.
	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	9.1.3.2.1 Provide examples of how diverse cultures, including natives from all of the Americas, have contributed scientific and mathematical ideas and technological inventions. *For example:* Native American understanding of ecology; Lisa Meitner's contribution to understanding radioactivity; Tesla's ideas and inventions relating to electricity; Watson, Crick and Franklin's discovery of the structure of DNA; or	Discussion on the background of all topics in the class.
			9.1.3.2.2 Analyze possible careers in science and engineering in terms of education requirements, working practices and rewards.	General discussion on the careers in Physics, Chemistry, Medicine, and what education requirements each field requires.
		3. Science and engineering operate in the context of society and both influence and are influenced by this context.	9.1.3.3.3 Describe how scientific investigations and engineering processes require multi-disciplinary contributions and efforts. *For example:* Nanotechnology, climate change, agriculture, or biotechnology.	Discussion on why many disciplines require a physics background and the importance of taking physics.

Bemidji Area Schools

Grades 11-12 General Physics Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	4. Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.	9.1.3.4.6 Analyze the strengths and limitations of physical, conceptual, mathematical and computer models used by scientists and engineers.	Acceleration Lab. Density Lab.
2. Physical Science	2. Motion	2. An object's mass and the forces on it affect the motion of an object.	9.2.2.2.1 Recognize that inertia is the property of an object that causes it to resist changes in motion.	Discussion and examples of Newton's 3 Laws of Motion.
			9.2.2.2.2 Explain and calculate the acceleration of an object subjected to a set of forces in one dimension (F=ma).	Discussion and examples of Newton's 3 Laws of Motion. Newton's 2nd Law Lab.
			9.2.2.2.3 Demonstrate that whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted by the second object back on the first object.	Discussion and examples of Newton's 3 Laws of Motion. Newton's 3rd Law Lab.
			9.2.2.2.4 Use Newton's universal law of gravitation to describe and calculate the attraction between massive objects based on the distance between them. *For example:* Calculate the weight of a person on different planets using data of the mass and radius of the planets.	Discussion and examples of Newton's Universal Law of Gravitation. Acceleration due to Gravity Lab.

Bemidji Area Schools

Grades 11-12 General Physics Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
2. Physical Science	3. Energy	2. Energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	9.2.3.2.1 Identify the energy forms and explain the transfers of energy involved in the operation of common devices. *For example:* Light bulbs, electric motors, automobiles or bicycles.	Discussion on conservation of energy. Types of energy. Potential and Kinetic Energy Lab.
			9.2.3.2.2 Calculate and explain the energy, work and power involved in energy transfers in a mechanical system. *For example:* Compare walking and running up or down steps.	Discussion on the work-kinetic energy theorem. Work and Power Lab.
			9.2.3.2.3 Describe how energy is transferred through sound waves and how pitch and loudness are related to wave properties of frequency and amplitude.	Wave demos. Discussion as waves being sound energy. Transverse waves depicting longitudinal waves.
			9.2.3.2.4 Explain and calculate current, voltage and resistance, and describe energy transfers in simple electric circuits.	Discussions and worksheet with Ohm's Law. Circuit Lab.
			9.2.3.2.5 Describe how an electric current produces a magnetic force, and how this interaction is used in motors and electromagnets to produce mechanical energy.	Computer electricity models from pHET Website. Investigating motors, generators and transformers from "How Stuff Works" Website.

Bemidji Area Schools

Grades 11-12 General Physics Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	3. Developments in physics affect society and societal concerns affect the field of physics.	9P.1.3.3.1 Describe changes in society that have resulted from significant discoveries and advances in technology in physics. *For example:* Transistors, generators, radio/television, or microwave ovens.	Discussion on the history of phones and computers.
		4. Physical and mathematical models are used to describe physical systems.	9P.1.3.4.1 Use significant figures and an understanding of accuracy and precision in scientific measurements to determine and express the uncertainty of a result.	Discussion on error analysis. Significant Figure Activity. Density Lab. Metric conversions.
2. Physical Science	2. Motion	1. Forces and inertia determine the motion of objects.	9P.2.2.1.1 Use vectors and free-body diagrams to describe force, position, velocity and acceleration of objects in two-dimensional space.	Discussion and examples on force diagrams. Vector drawings and worksheets.
			9P.2.2.1.2 Apply Newton's three laws of motion to calculate and analyze the effect of forces and momentum on motion.	Discussion and examples on Newton's 3 Laws and Momentum Questions on problem worksheet. Newton's 2nd Law Lab.
			9P.2.2.1.3 Use gravitational force to explain the motion of objects near Earth and in the universe.	Discussion and examples on Newton's Law of Universal Gravitation. Acceleration Lab. Demos falling objects.
		2. When objects change their motion or interact with other objects in the absence of frictional forces, the total amount of mechanical energy remains constant.	9P.2.2.2.1 Explain and calculate the work, power, potential energy and kinetic energy involved in objects moving under the influence of gravity and other mechanical forces.	Discussion and examples on Energy and Collisions. Kinetic and potential energy lab. Work and power lab.
			9P.2.2.2.2 Describe and calculate the change in velocity for objects when forces are applied perpendicular to the direction of motion. *For example:* Objects in orbit.	Discussion on Centripetal Acceleration and Force. Swinging Ball Over Heaad Demo. *Roller Coaster* video.
			9P.2.2.2.3 Use conservation of momentum and conservation of energy to analyze an elastic collision of two solid objects in one-dimensional motion.	Discussion and examples on energy and collisions. Conservation of momentum problems and types of collisions.

Bemidji Area Schools

Grades 11-12 General Physics Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
2. Physical Science	3. Energy	1. Sound waves are generated from mechanical oscillations of objects and travel through a medium.	9P.2.3.1.1 Analyze the frequency, period and amplitude of an oscillatory system. *For example:* An ideal pendulum, a vibrating string, or a vibrating spring-and-mass system.	Discussion and examples on Harmonic Motion. Pendulum Lab. Wave Frequency Demos.
			9P.2.3.1.2 Describe how vibration of physical objects sets up transverse and/or longitudinal waves in gases, liquids and solid materials.	Discussion and examples on Harmonic Motion. Wave demonstrations. Discussion regarding transverse waves depicting longitudinal waves.
			9P.2.3.1.3 Explain how interference, resonance, refraction and reflection affect sound waves.	Discussion on the properties of waves. Demo of tuning fork interference. YouTube videos on glass breaking from sound waves and why.
			9P.2.3.1.4 Describe the Doppler effect changes that occur in an observed sound as a result of the motion of a source of the sound relative to a receiver.	Discussion and examples of the Doppler Effect.
		2. Electrons respond to electric fields and voltages by moving through electrical circuits and this motion generates magnetic fields.	9P.2.3.2.1 Explain why currents flow when free charges are placed in an electric field, and how that forms the basis for electric circuits.	Discussion of potential difference. Computer simulation on how ions repel or attract other charged ions.
			9P.2.3.2.2 Explain and calculate the relationship of current, voltage, resistance and power in series and parallel circuits. *For example:* Determine the voltage between two points in a series circuit with two resistors.	Relationship of Ohm's Law discussion and calculations. Circuit Lab.
			9P.2.3.2.3 Describe how moving electric charges produce magnetic forces and moving magnets produce electric forces.	Demonstration of magnet and iron filings. Show how compas reacts to electricity flowing through wires.
			9P.2.3.2.4 Use the interplay of electric and magnetic forces to explain how motors, generators, and transformers work.	Computer investigation of motors, generators and transformers.

Bemidji Area Schools

Grades 11-12 General Physics Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
2. Physical Science	3. Energy	3. Magnetic and electric fields interact to produce electromagnetic waves.	9P.2.3.3.1 Describe the nature of the magnetic and electric fields in a propagating electromagnetic wave.	Discussion of EM spectrum in class regarding types of waves and how formed.
			9P.2.3.3.2 Explain and calculate how the speed of light and its wavelength change when the medium changes.	Discussion of light waves as it enters water and glass. Why is sky blue or red in morning. Why does sun or moon look so big at times like dusk. Speed of light calculation worksheet.
			9P.2.3.3.3 Explain the refraction and/or total internal reflection of light in transparent media, such as lenses and optical fibers.	Explain role of fiber optics in class. Demo of internal reflection through plastic tube.
		3. Magnetic and electric fields interact to produce electromagnetic waves.	9P.2.3.3.4 Use properties of light, including reflection, refraction, interference, Doppler effect and the photoelectric effect, to explain phenomena and describe applications.	Discussion and examples on the properties of light. Computer simulation on interference and refraction. Refraction Lab and Demos.
			9P.2.3.3.5 Compare the wave model and particle model in explaining properties of light.	Discussion and reading from text on two theories of light particle movement.
			9P.2.3.3.6 Compare the wavelength, frequency and energy of waves in different regions of the electromagnetic spectrum and describe their applications.	Discussion and text reading on the types of EM waves as well as the EM spectrum. Discussion as to why we have different colors. Color Lab.
		4. Heat energy is transferred between objects or regions that are at different temperatures by the processes of convection, conduction and radiation.	9P.2.3.4.1 Describe and calculate the quantity of heat transferred between solids and/or liquids, using specific heat, mass and change in temperature.	Discussion on Heat Transfer and Radiation. Specific Heat Lab. Heat of Fusion and Latent Heat discussion.
			9P.2.3.4.2 Explain the role of gravity, pressure and density in the convection of heat by a fluid.	Discussion and investigation of heat pumps and the refrigeration, air conditioning process.
			9P.2.3.4.3 Compare the rate at which objects at different temperatures will transfer thermal energy by electromagnetic radiation.	Discussion on Heat Transfer and Radiation. Specific Heat Lab.